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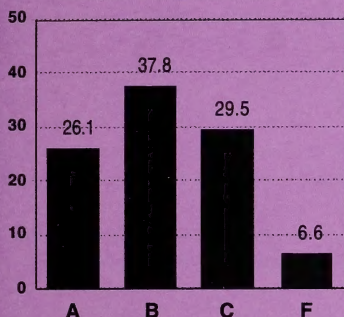


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Chemistry 30

Diploma Examination Results Examiners' Report for January 1996

School-Awarded Mark



The summary information in this report provides teachers, school administrators, students, and the general public with an overview of results from the January 1996 administration of the Chemistry 30 Diploma Examination. This information is most helpful when used with the detailed school and jurisdiction reports that have been mailed to schools and school jurisdiction offices. An annual provincial report containing a detailed analysis of the combined January, June, and August results is published each year.

Description of the Examination

The Chemistry 30 Diploma Examination consists of 44 multiple-choice questions worth 55%, 12 numerical-response questions worth 15%, and 2 written-response questions worth 30% of the total examination mark.

Achievement of Standards

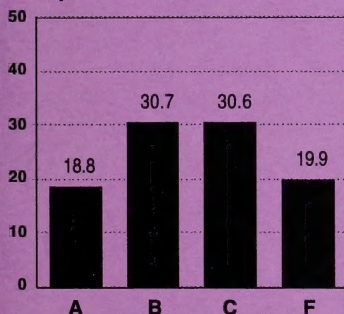
The information reported is based on the final course marks achieved by 7 209 students in Alberta who wrote the January 1996 examination. This represents an increase of 459 compared with January 1995.

- 91.0% of the 7 209 students achieved the acceptable standard (a final course mark of 50% or higher).
- 20.6% of these students achieved the standard of excellence (a final course mark of 80% or higher).

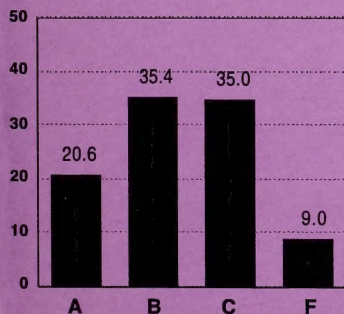
Overall, student achievement in Chemistry 30 was acceptable, particularly in knowledge of core concepts. However, students had difficulty with the concept of equilibrium, and in organizing and communicating their chemistry knowledge.

Approximately 51.2% of the students who wrote this examination were female, which is similar to the percentage of females in the population at this age group. The acceptable standard on the examination was achieved by approximately 77.0% of this female population, compared with 83.4% of the male population. Approximately 15.3% of the female population achieved the standard of excellence on the examination, compared with 22.2% of the male population.

Diploma Examination Mark



Final Course Mark



Provincial Averages

- The average school-awarded mark was 69.2%.
- The average diploma examination mark was 63.9%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 66.9%.

Approximately 10.4% of the students who wrote the examination in January 1996 and received a

school-awarded mark had written at least one other Chemistry 30 Diploma Examination during the January 1994 to January 1995 period. This sub-population (716) did not do as well (61.6%) as the population (6 493) who first wrote a Chemistry 30 examination (64.2%) in January 1996. However, the group of students who rewrote the chemistry examination increased their score, on average, 10.1%.

Results and Examiners' Comments

This examination has a balance of question types and difficulties. It is designed so that students capable of achieving the acceptable standard will obtain a mark of 50%, and students capable of achieving the standard of excellence will obtain a mark of 80%. Future examinations will continue to require students to demonstrate clarity in their thinking and an understanding of concepts by applying their knowledge to new and novel situations. Students will also continue to be required to present their answers in a clear, concise, organized fashion and to respect the conventions of the mode of communication selected. Those who achieved these expectations were successful in this examination.

In the following table, diploma examination questions are classified by question type: multiple choice (MC), numerical response (NR), and written response (WR). The column labelled "Key" indicates the correct response for multiple-choice and numerical-response questions. For numerical-response questions, a limited range of answers was accepted as being equivalent to the correct answer.

For multiple-choice and numerical-response questions, the difficulty indicates the proportion (out of 1) of students answering the question correctly. For written-response questions, the difficulty is the mean score achieved by students who wrote the examination.

Questions are also classified by general learner expectations.

Knowledge:

- GLE 1 Quantitatively Predicting Outcomes
- GLE 2 Qualitatively Analyzing Systems
- GLE 3 Relationships in Energy Transfer
- GLE 4 Relationships in Electron Transfer
- GLE 5 Relationships in Equilibrium Systems
- GLE 6 Relationships in Proton Transfer

Skills:

- SPSC Scientific Process Skills and Communication Skills

Science, Technology, Society:

- STS Connections Among Science, Technology, & Society

Blueprint

Question	Key	Difficulty	GLE 1	GLE 2	GLE 3	GLE 4	GLE 5	GLE 6	SPSC	STS
MC 1	C	0.894		✓	✓				✓	
MC 2	A	0.585		✓	✓				✓	✓
NR 1	22.5	0.897	✓		✓				✓	✓
NR 2	*	0.541	✓		✓				✓	✓
MC 3	C	0.704		✓	✓				✓	✓
MC 4	C	0.751	✓		✓				✓	
MC 5	B	0.761		✓	✓				✓	
MC 6	A	0.719		✓	✓				✓	✓
MC 7	A	0.561	✓		✓				✓	✓
MC 8	C	0.498	✓		✓				✓	✓
MC 9	B	0.820		✓		✓	✓	✓	✓	✓
MC 10	B	0.836	✓		✓				✓	
NR 3	36.4	0.776	✓		✓				✓	
NR 4	14.5	0.633	✓		✓				✓	✓
MC 11	A	0.548		✓	✓	✓		✓		✓

Question	Key	Difficulty	GLE 1	GLE 2	GLE 3	GLE 4	GLE 5	GLE 6	SPSC	STS
MC 12	D	0.483	✓	✓	✓				✓	✓
MC 13	A	0.722		✓	✓		✓	✓		✓
NR 5	2356**	0.620		✓	✓				✓	
MC 14	B	0.545		✓	✓					
MC 15	D	0.473		✓			✓			✓
MC 16	B	0.561		✓	✓	✓				
MC 17	A	0.849		✓		✓				
MC 18	A	0.921		✓		✓			✓	
MC 19	D	0.638	✓			✓				✓
MC 20	C	0.675		✓		✓			✓	
MC 21	B	0.742		✓		✓				✓
MC 22	C	0.882		✓		✓		✓	✓	
MC 23	B	0.762		✓		✓			✓	✓
MC 24	A	0.848	✓			✓			✓	✓
MC 25	B	0.620		✓		✓			✓	✓
MC 26	C	0.451		✓		✓			✓	✓
NR 6	1.59	0.734	✓			✓			✓	✓
MC 27	B	0.910		✓	✓	✓			✓	✓
MC 28	D	0.554		✓		✓	✓		✓	✓
NR 7	***	0.138	✓			✓			✓	✓
MC 29	C	0.514		✓		✓		✓		✓
MC 30	D	0.314		✓			✓	✓	✓	
NR 8	1705	0.657	✓			✓			✓	✓
NR 9	13.3	0.648	✓							✓
MC 31	A	0.944		✓				✓		✓
MC 32	D	0.601	✓		✓			✓	✓	✓
MC 33	A	0.904		✓				✓	✓	✓
MC 34	D	0.718		✓			✓			✓
NR 10	1324	0.660	✓	✓				✓		✓
MC 35	C	0.437	✓				✓	✓		✓
MC 36	D	0.766		✓			✓	✓	✓	
MC 37	D	0.645		✓		✓		✓		✓
NR 11	2.84	0.395	✓				✓	✓	✓	✓
MC 38	C	0.779	✓	✓				✓	✓	
NR 12	2431	0.788	✓					✓	✓	
MC 39	A	0.643	✓					✓	✓	
MC 40	C	0.669		✓			✓	✓		
MC 41	B	0.723		✓				✓		
MC 42	C	0.613		✓			✓	✓		
MC 43	D	0.509		✓			✓	✓		✓
MC 44	A	0.767	✓	✓				✓	✓	
WR1	—	0.693	✓	✓			✓			
WR2	—	0.428		✓		✓			✓	✓

* answer = NR1 (110.98/83)

** in any order

*** if MC 28 was A then, 25.3

B then, 2741

C then, 35.2

D then, 2.23

Subtest

When analyzing detailed results, please bear in mind that subtest results **cannot** be directly compared. Results are in average raw scores.

Multiple choice and numerical response: 37.4 out of 56

Written Response: 13.6 out of 24

GLE 1	Quantitatively Predicting Outcomes	23.0	out of	35
GLE 2	Qualitatively Analyzing Systems	37.3	out of	57
GLE 3	Relationships in Energy Transfer	14.2	out of	21
GLE 4	Relationships in Electron Transfer	17.1	out of	28
GLE 5	Relationships in Equilibrium Systems	19.1	out of	32
GLE 6	Relationships in Proton Transfer	14.5	out of	22
SPSC		27.4	out of	44
STS		33.5	out of	54

Multiple-Choice and Numerical-Response Questions

The following questions were selected for discussion because they exemplify what is required to meet, minimally, the acceptable standard and the standard of excellence.

Kelly tested portions of a solution with three indicators to determine the approximate pH.

Indicator	Colour
bromocresol green	blue
indigo carmine	blue
thymolphthalein	blue

38. The approximate pH of the solution is

- A. 5.0
- B. 9.0
- *C. 10.8
- D. 11.6

Numerical Response

1. The energy involved in changing the temperature of 1.00 kg of water 5.36° C is _____ kJ.
(Record your answer to three digits on the answer sheet.)

Answer: 22.5

Use your recorded value from Numerical Response 1 to answer Numerical Response 2..

Numerical Response

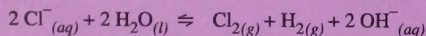
2. The dissolving of calcium chloride is represented by the equation

$$\text{CaCl}_{2(s)} \rightarrow \text{Ca}^{2+}_{(aq)} + 2 \text{Cl}^{-}_{(aq)} \quad \Delta H = -83.0 \text{ kJ/mol}$$

 The mass of $\text{CaCl}_{2(s)}$ required to cause the change in numerical-response question 1 is _____ g.
 (Record your answer to three digits on the answer sheet.)

Answer: NR1 (110.98/83)

30. Which observation would **not** be useful to determine if the reaction below has reached equilibrium?



- A. The pH
- B. The total gas pressure
- C. The colour of the gas above the liquid
- *D. The electrical conductivity of the solution

Students just achieving the acceptable standard were capable of answering questions such as multiple-choice questions 5, 9, 10, 23, 36, 38, and 44, and numerical-response questions 1 and 12. For example, in **multiple-choice question 38**, most students (77.9%) were able to determine the pH of a solution by the colours of an acid-base indicators. The majority of students who achieved the acceptable standard (77.7%) or better (91.7%) had success on this question, while students who did not achieve the acceptable standard had limited success (47.2%). The results for this question suggest that students who do not achieve the acceptable standard have difficulty in using data tables to extract appropriate information about fundamental ideas such as pH and acid-base indicators.

In **numerical-response question 1**, most students (89.7%) perform a routine single-step calculation to determine the kinetic energy involved in a change of water. Virtually all students who achieved the standard of excellence (97.4%) and the students who only achieved the acceptable standard (90.9%) were successful. Most of the students (63.5%) who did not achieve the acceptable standard were also able to do this. The most common mistakes that students made were in believing that 1.00 kg contains 100 g (1.0%) and that the temperature change had no effect on the amount of energy involved (0.5%). When students are asked to calculate the amount of calcium chloride required to produce this change, as in soft-linked numerical-response question 2, they are not as successful. In **numerical-response question 2**, a little over half of the students (54.1%) were successful, and most of these students (96.4%) were able to answer the preceding question correctly. The majority of the students who achieved the standard of excellence (89.1%) were capable of performing multistep calculations to arrive at a valid answer. Students achieving just the acceptable standard (49.2%) had difficulty performing multistep calculations, while students who did not achieve the acceptable standard were not very successful (12.7%). This suggests that students capable of applying more than one skill or concept to a problem to arrive at an answer will achieve the acceptable standard.

Students just achieving the standard of excellence were capable of answering questions such as multiple-choice questions 30 and 35, and numerical-response questions 7 and 11. For example, in **multiple-choice question 30**, most students (68.6%), as expected, could not relate observations to a system in equilibrium. As a result, only 31.4% of all students were successful in answering this question correctly. The most common mistake made by students was believing that either colour (30.8%) or pressure (26.5%) is independent of concentration. Students who achieved the standard of excellence (46.3%) were successful in answering this

question, while students who achieved the acceptable standard had limited success (28.4%), and students who did not achieve the acceptable standard had very poor success (21.1%). These results suggest that students who did not achieve the standard of excellence were most likely guessing at the answer rather than applying skills or concepts. This suggests that students who achieve the standard of excellence do so because they are able to understand the concept of equilibrium and extrapolate this knowledge into a lab-based situation.

In numerical-response question 7, 92.2% of the students answering the question correctly were able to identify the appropriate cathode half-reaction. Students achieving the standard of excellence were able to identify the correct cathode half-reaction (86.9%) and then determine the mass of product formed at the cathode (45.4%). Half of the students (50.8%) who achieved the acceptable standard could identify the cathode half-reaction, but very few (6.2%) were able to determine the mass produced at the cathode. Very few of those who did not achieve the acceptable standard were able to identify the correct cathode half-reaction (19.7%) and then calculate the mass of cathode product (0.8%). The most common mistake made by all students was in assuming that the mass of product formed at the cathode would be the same as the mass of product formed at the anode (26.6%). The results for this question suggest that students achieving the standard of excellence do so because they are capable of combining concepts and performing multistep calculations.

Numerical Response

A If the mass of the element formed at the anode is 78.1 g, the mass of element formed at the cathode is _____ g.

(Record your answer to three digits on the answer sheet.)

Answer: If MC28 was A, then 25.3

B, then 2741

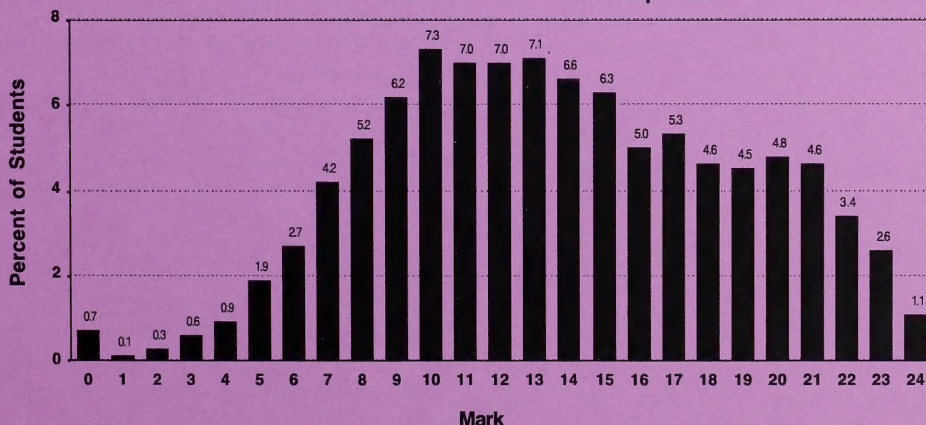
C, then 35.2

D, then 2.23

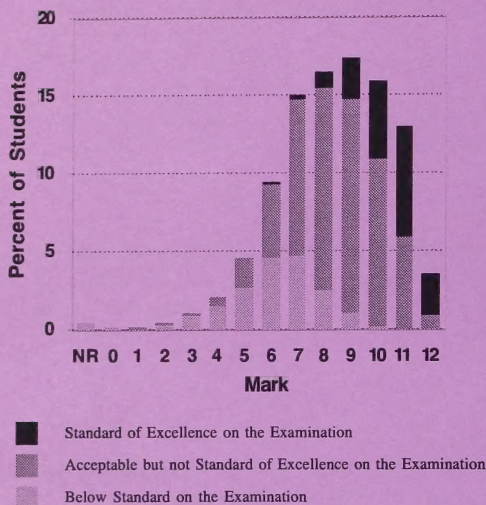
Written-Response Questions

The level of achievement on the written-response section was as expected: almost two-thirds of the students (62.9%) achieved a mark of 12 or higher out of 24. The average mark on the written-response section was 13.6 or 56.8% of the available marks.

Distribution of Marks for Written Response



Distribution of Marks for Question 1

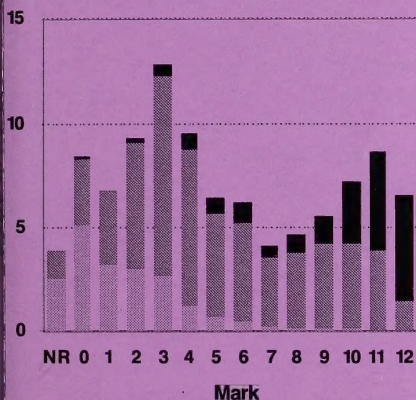


Written-response question 1 was not answered as well as expected. The question was selected to measure students' ability to graph data, interpret graphs, set up an equilibrium expression, and then solve the expression. Students were also required to use their knowledge to describe any two methods that could be used to increase the yield of product. Students who did not achieve the acceptable standard were expected to score up to 7, and 80.0% did so. They averaged 5.97 by graphing the data and determining a valid time for the equilibrium to be established. The most common problems these students had in graphing the data were in reversing axis selecting uniform scales, and in connecting the data points rather than drawing smooth curves. These students wrote a K_a expression for the ammonia rather than an appropriate equilibrium expression. These students had no idea how to apply LeChâtelier's Principle to this situation. Most of these students' responses were poorly organized and weakly communicated. Error in spelling and grammar were the norm.

Students who achieved the acceptable standard but not the standard of excellence on the examination were expected to score in the range of 8 to 10, and 60.6% did so. They averaged 8.44 by using excellent graphing skills to accurately graph the data, identifying the time at which equilibrium is reached, and stating one valid method of shifting the equilibrium to the product side. Generally, they covered one method of shifting the equilibrium very well but had difficulty with a second method. The most common mistake they made was in adding more reactants; however, the question specified that they must find two methods of altering the equilibrium other than by adding more reactants. Another common mistake associated with applying LeChâtelier's Principle was a lack of understanding of equilibrium as applied to the entire system rather than just the products or just the reactants. This group of students had difficulty in writing a valid K_{eq} expression, performing routine calculations such as 0.30^3 (equaled 0.90), and determining the appropriate number of significant digits for the final answer. Like the students who did not achieve the acceptable standard, the students who achieved the acceptable standard wrote K_a expressions for the ammonia rather than an appropriate equilibrium expression. Another common mistake was in using the value of the molar enthalpy of formation of ammonia as K_{eq} .

Students who achieved the standard of excellence were expected to score 11 or better, and 51.6% did so. They averaged 10.3 by concisely communicating clear answers, writing and solving the correct K_{eq} expression, selecting a time to reach equilibrium consistent with their perfectly constructed graphs, and selecting two valid methods to increase the yield.

Distribution of Marks for Question 2



Standard of Excellence on the Examination

Acceptable but not Standard of Excellence on the Examination

Below Standard on the Examination

ammonia. The only weakness noted was that when students chose to include units in their calculations, they had difficulty in determining the correct units. This may be due to an unfamiliarity with the wide range of "atypical" units that arise. Regardless of the methods selected, these students showed good communication and organizational skills.

The results on this question suggest that most students achieving the acceptable standard are capable of accurately graphing data, extracting information from graphed data, and applying LeChâteliers Principle. The students who achieve the standard of excellence do so because they can accurately graph data, extract information from graphs, write and accurately solve K_{eq} expressions, and understand LeChâteliers Principle.

On this 12-mark question, the average mark was 8.31 or 69.3% of the available mark.

Written-response question 2 was answered better than expected by students. The question was selected to measure students' ability to relate their understanding of chemistry to a real-world Alberta context that should have been new to them. They were not expected to know the actual chemistry behind the sign, but to hypothesize. As a result, there was a vast range of ideas presented by the students, many of which were both correct and novel. All answers were judged on their own merit, and if they dealt with corrosion and were adequately explained, awarded full marks

Students who did not meet the acceptable standard were expected to score up to 3, and 84.2% meet this expectation. They averaged 1.76 because they recognized that redox chemistry was involved, and could write half-reactions. These students understood related definitions of reduction and oxidation. Unfortunately, they were unable to relate these terms to cathodic protection. They showed great difficulty in distinguishing between anodes and cathodes, and in providing an example. These students' responses lacked cohesion because they attempted to answer the question by dealing with each individual bullet as a separate question, rather than items required in a complete response. This approach resulted in a series of answers with no common thread and, in some cases, contradictory information. As a result, markers had to interpret these students' responses, which, in many cases, contained numerous convention errors.

Students who achieved the acceptable standard but not the standard of excellence were expected to score from 3 to 7 and scored, on average, 5.19. In total, 49.1% of these students met this expectation. They recognized the process of cathodic protection as a method of preventing corrosion and provided half-reactions relevant to corrosion. Most students recognized

that oxygen or water was involved; however, they failed to connect the two reagents when they wrote half-reactions. These students approached the question from the perspective of sacrificial anodes and provided suitable examples of how and why this technology would be used. One result of this approach to answering the question was the reversal of anodes and cathodes in the labelling of half-reactions, or the object being protected, usually an iron object. These students' responses tended to ramble but they were "whole," rather than a series of answers to individual bullets.

Students who achieved the standard of excellence were expected to score 8 or better and average 9.58 for this question, and 79.4% did so, with 27.0% attaining a perfect score. Students achieving the standard of excellence do so because they can analyze a situation and can make an informed guess. These students understood that the sign showed that a method of corrosion protection was indicated and they applied the concept of sacrificial anodes very well to this situation. They were able to write appropriate, practical half-reactions, including states, and present and explain good examples that were both practical and plausible. These students presented their answers in a concise, well-organized fashion, and expressed themselves clearly to the markers so that little, if any, interpretation was required. Many students chose to include diagrams, generally of excellent quality, to help illustrate their answer. The only areas of weakness noted were careless errors involving non-standard shorthand notation, and the coining of the term "sacrificial cathode."

On this 12-mark question, the average mark was 5.14 or 42.8% of the available mark.

For further information, contact Don Loerke (dloerke@edc.gov.ab.ca) or Yvonne Johnson (yjohnson@edc.gov.ab.ca) at the Student Evaluation Branch, 1-403-427-0010.

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